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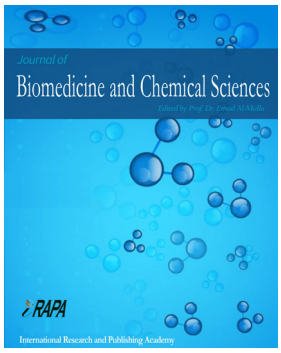

Risk Factors Associated with Urinary Schistosomiasis and Its Spatial Distribution Among Almajirai in Selected Localities in Katsina State, Nigeria

Timothy Auta[1*], Hafsat Sada Rufai[1], James Bemshima Orpin[1] & Emmanuel Dayo Alabi[2]

[1] *Department of Biological Sciences, Federal University Dutsin-Ma, Katsina State, Nigeria*
[2] *Department of Microbiology, Federal University Dutsin-Ma, Katsina State, Nigeria*

[*]*Corresponding author:* Timothy Auta | e-mail: autatimz@gmail.com

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ABSTRACT

Urinary schistosomiasis is a chronic neglected tropical disease (NTD), which is endemic in Nigeria, and is largely attributable to poverty. This study sought to determine the risk factors associated with urinary schistosomiasis and its spatial distribution in Safana, Dutsin-Ma, and Kurfi towns of Katsina State, Nigeria. Urine samples were collected from thirteen Tsangaya schools between 1st June and 30th September 2023, the participants' samples and socio-demographic data were analyzed for the ova of *Schistosoma haematobium* and associated risk factors using the centrifugation technique and Chi-square tests, respectively. Out of the 514 samples examined, 35.6% were positive for the ova of *S. haematobium*. The predisposing risk factors for the infection included; contact with large water bodies ($\chi 2$= 0.2060, P=0.6500), and age group ($\chi 2$=50.6220, P=0.0000). Participants with haematuria recorded a higher prevalence (49.7%) than those with no haematuria (17.1%), and the infection was significantly associated with haematuria ($\chi 2$= 58.2460, P= 0.0000). The source of water, contact with water bodies, age group, and lack of a history of praziquantel treatment were identified as risk factors for the infection. To prevent continuous transmission of the disease, the study recommends improved environmental sanitation and regular mass deworming of Almajirai.

INTRODUCTION

Schistosomiasis (Bilharziasis) is a significant tropical disease that has been neglected. It is second to malaria regarding parasite-induced morbidity and mortality (Golan et al., 2008). Schistosomiasis occurs as either an acute or a chronic parasitic disease. It is endemic in many developing countries in tropical and sub-tropical Africa, the Middle East, Asia, and Latin America. About 90% of the global burden of schistosomiasis is found in Sub-Saharan Africa (Auta et al., 2020). The agents of Schistosomiasis are the digenic blood flukes (trematode worms) of the genus *Schistosoma* (Toor et al., 2020). This neglected infectious disease is attributable to poverty, and is endemic in resource-constrained regions. Water bodies contaminated with cercariae from *Bulinus* snails (the intermediate host) serve as a medium for human infection when it penetrates unbroken skin. In the body, the larvae develop into adult *Schistosomes* and migrate to the vesical and pelvic venous plexuses, where the female *Schistosomes* lay eggs in the urinary bladder and the ureters. This condition leads to the formation of ulcers and the symptoms of urinary tract infection due to the accumulation of eggs in the bladder tissues (Barsoum, 2013). The infection is characterized by bloody urine (haematuria), lesions of the bladder, kidney failure, and bladder cancer (Butterworth, 2007).

The Almajiri education system is an informal system

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of education, which has been a longstanding tradition among Muslims in Northern Nigeria and neighboring countries. The students (pupils) are sent to a Mallam (teacher) to learn the Quran in Tsangaya schools (TS), where the students (pupils) reside separately from their families and attend TS on a full-time basis. They typically spend over eight years within the Almajiri educational system (Mashema et al., 2018). Often they lacked the basic resources and support from their teachers, leaving them vulnerable, and having to fend for themselves from a young age. This self-sustaining lifestyle typically begins when they are between 5 and 19 years old (Amzat, 2001; Auta et al., 2020).

Approximately 236 million people are infected with *S. haematobium* globally, with an estimated 140 million newly infected people annually, according to the World Health Organization (WHO). The majority of the new cases occur in underprivileged rural areas of sub-Saharan Africa (WHO, 2016). In contrast, public health control measures to contain urinary schistosomiasis have been effectively implemented in nations like China, Brazil, Egypt, and Japan (Bamgbola, 2014). However, despite numerous attempts to reduce the national burden of urinary schistosomiasis in Nigeria through school-based interventions, the region has remained a significant hotspot in the global schistosomiasis crisis. This is due to the scarcity of comprehensive data regarding the disease's geographic spread, necessitating the need to determine its current prevalence in various localities and to develop and recommend appropriate control measures (Gamde et al., 2023). Thus, the study sought to determine the current prevalence, spatial distribution, and risk factors associated with urinary schistosomiasis in Safana, Dutsin-Ma, and Kurfi towns of Katsina State, Nigeria

MATERIALS & METHODS

Study Areas

The study was conducted in Dutsin-Ma, Kurfi, and Safana Towns of Katsina State, Nigeria. The three (3) towns are situated in Dutsin-Ma, Kurfi, and Safana Local Government Areas (LGAs) respectively, in the western region of Katsina state, Nigeria (Figure 1).

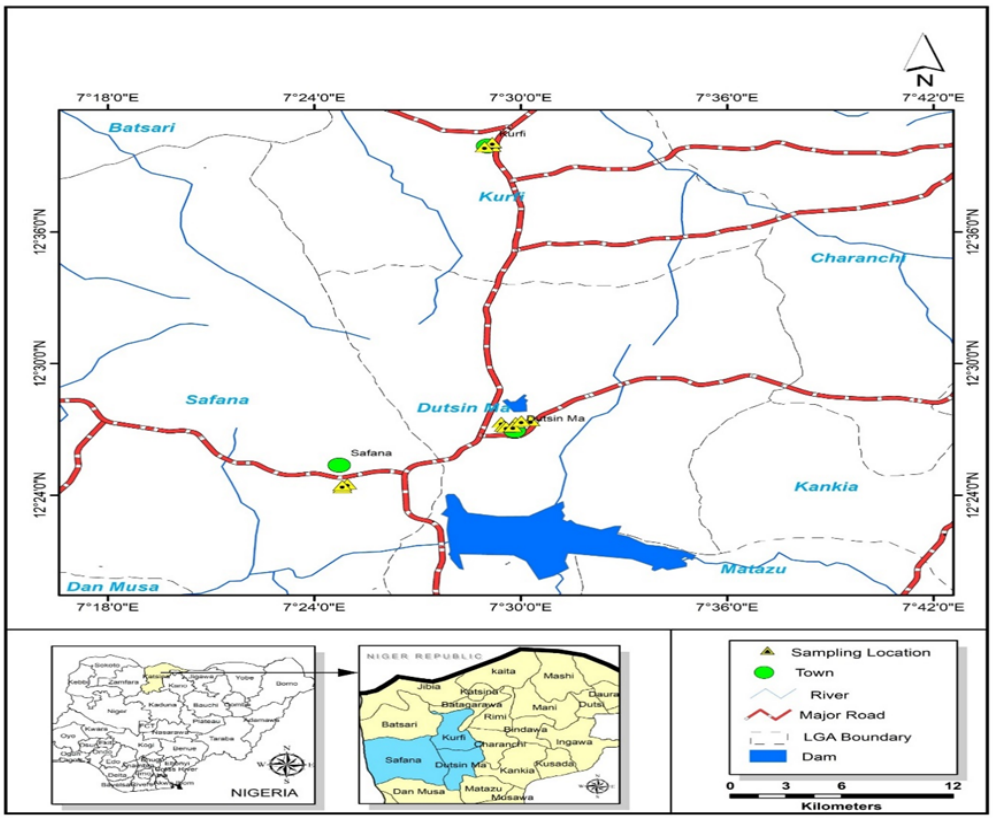

Fig. 1. Map showing sampling locations in Dutsin-Ma, Kurfi, and Safana Towns as adapted from the open street map and Google Earth Imagery 2023

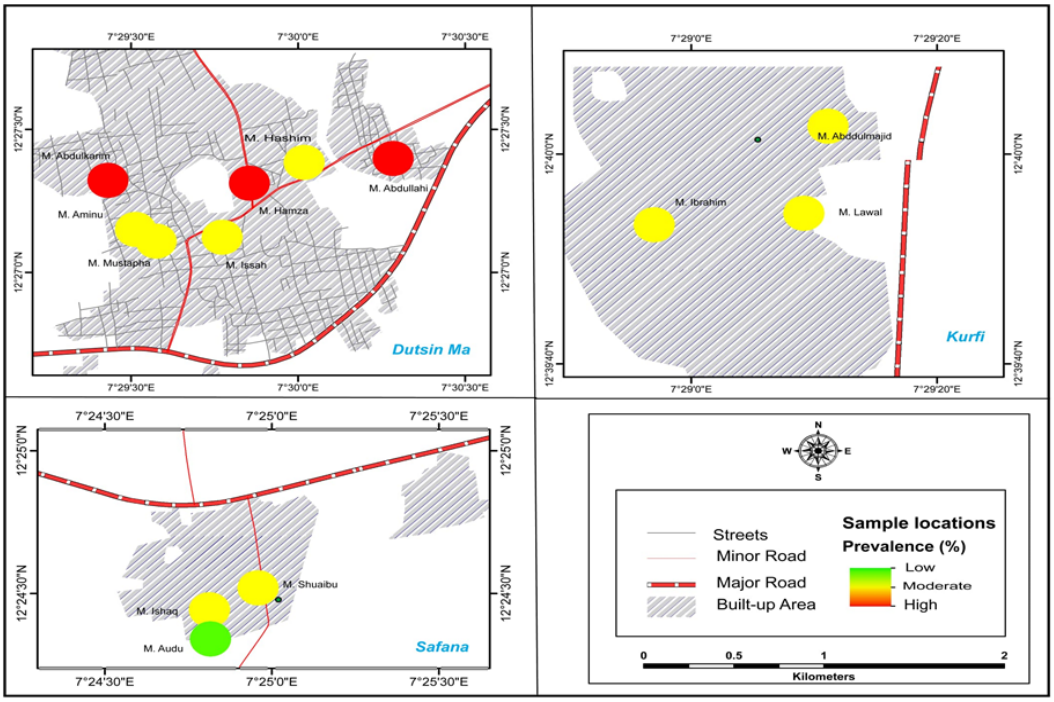

Fig. 2. Spatial distribution of the prevalence of Urinary schistosomiasis in the TS surveyed

Study Design and Population

This study used a randomized cluster design and a cross-sectional approach of random urine sample collection from the Almajirai, between 1st June and 30th September 2023.

Sample Size Determination

The sample size for the study was determined using the single proportion formula, assuming a 21.3% proportion of urinary schistosomiasis from a previous study conducted by Auta *et al.* (2020). A 95% confidence level and 5% precision were used. The single proportion formula used is $n = Z^2 P (1- P)/d^2$, where; **n** is the sample size, **Z** is the alpha risk represented in the z-score, **P** is the predicted prevalence, and **d** is the absolute precision.

After calculation, a total of 514 participants were selected using a random sampling technique. The participants were from Mallam Ishaq TS, Mallam Shuaibu TS, Mallam Audu TS, Mallam Abdulmajid TS, Mallam Ibrahim TS, Mallam Lawal TS, Mallam Hashimu TS, Mallam Aminu TS, Mallam Isa TS, Mallam Hamza TS, Mallam Abdulkarim TS, Mallam Abdullahi TS, and Mallam Mustapha TS respectively.

Data Collection: Questionnaire Survey

Structured questionnaires were administered to the participants, and questions were asked regarding their sex, age, origin, parent's occupation, educational background, contact with water bodies, etc.

Urine Sample Collection

Each participant was provided a clean universal bottle labeled with their name and code. They were required to fill the bottle with urine between 10:00 am and 2:00 pm, as this was the optimal time to detect the presence of the ova in urine due to the circadian rhythm of the parasite. The collected samples were placed in a dark polyethylene bag kept cool in ice-packed containers, and transported to the Biology Laboratory at the Federal University Dutsin-Ma for further analyses.

Ethical Statement

The State Ministry of Health Ethical Clearance Committee in Katsina State reviewed and approved the study protocol under approval number MOH/ADM/SUB/1152/1/555. Informed consent was obtained from the guardians (Mallams) of the Almajirai who were selected for the study. Those who did not consent or were unwilling to participate were not included in the study. Participants were also given the liberty to withdraw from the study at any time.

Urine Microscopy

To examine the urine samples for the eggs of *S. haematobium*, the urine samples were mixed, and ten (10) mL of each was transferred to a clean centrifuge tube and spun at 1500 revolutions per minute (rpm) for 5 minutes using a C2 series Centurion Scientific Centrifuge (Sussex, United Kingdom). The resulting sediment was examined under a compound (binocular) microscope (Motic™ Wetzlar, Germany) using x10 objective lens. The presence of the ova of

S. haematobium was confirmed by identifying their distinctive terminal spine using x 40 objective lens (Cheesbrough, 2005).

Statistical Analysis

Statistical packages for social science software version 20.0 (Illinois, USA) were used to analyze the data. Chi-square and Odd Ratio at 95% CI were used to measure the strength of association between variables. Values were considered statistically significant at 95% CI and a P-value of ≤ 0.05.

RESULTS & DISCUSSION

A total of 514 urine samples collected from thirteen (13) TS in three (3) different towns, namely: Dutsin-Ma, Kurfi, and Safana were examined in the study. Among the participants examined, 172 were from Dutsin-Ma, 65 were from Kurfi, and 277 were from Safana towns respectively. Overall, the current prevalence of infection in the study localities is 35.6%. Among the three study areas, Dutsin-Ma Town, had the highest prevalence of infection at 46.5%, followed by Safana with a prevalence of 31.4%, and Kurfi had the lowest prevalence rate of 24.6% (Table 1).

Table 1

Prevalence of Urinary schistosomiasis among Almajiris in Dutsin-Ma, Kurfi, and Safana Towns

Study area	Number of Samples Examined	Number of Sample Positive	Prevalence (%)
Dutsin-Ma	172	80	46.5
Kurfi	65	16	24.6
Safana	277	87	31.4
Total	514	183	35.6
$\chi 2$			14.4760
P-value			0.0010

On the other hand, Mallam Hamza TS recorded the highest prevalence of 60.7%, while Mallam Audu TS had the lowest prevalence (6.9%) among the Tsangaya schools studied (**Table 2**).

Table 2

Prevalence of urinary schistosomiasis among Tsangaya schools in Dutsin-Ma, Kurfi, and Safana Towns

School	Number of Samples Examined	Number of Sample Positive	Prevalence (%)
Mallam Ishaq TS	180	75	41.6
Mallam Shuaibu TS	68	10	14.7
Mallam Audu TS	29	2	6.9
Mallam Abdulmajid TS	8	1	12.5
Mallam Ibrahim TS	35	6	17.1
Mallam Lawal TS	22	9	40.9
Mallam Hashimu TS	39	14	14.4
Mallam Aminu TS	23	10	43.5
Mallam Isa TS	28	10	35.7
Mallam Hamza TS	28	17	60.7
Mallam Abdulkarim TS	26	15	57.7
Mallam Abdullahi TS	12	7	58.3
Mallam Mustapha TS	16	7	43.8
Total	514	183	35.6
$\chi 2$		50.6220	
P-value		0.0000	

The risk factors associated with urinary schistosomiasis infections among the participants in this study include; the source of water, frequency of visits to rivers and dams, contact with large water bodies, and the use of large water bodies for recreational activities (Table 3).

Table 3
Risk factors associated with the prevalence of urinary schistosomiasis among Almajiris in Dutsin-Ma, Kurfi, and Safana Towns

Category	Number of samples Examined	Number of samples positive	Prevalence (%)
Source of water			
Well	11	3	27.3
Tap	4	0	0.0
River	350	127	36.3
Stream	20	8	40.0
Others	129	45	34..9
$\chi 2$		2.8130	
P-value		0.5900	
Contact with water body			
Yes	416	149	35.8
No	98	34	34.7
$\chi 2$		0.2060	
P-value		0.6500	
Type of Water Body			
River	301	93	30.9
Dam	115	56	48.7
Not applicable	98	34	34.7
$\chi 2$		25.6160	
P-value		0.0000	
Purpose of visit			
Bathing and playing	299	119	39.8
Fetching water	107	28	26.2
Fishing	9	2	22.2
Others	1	0	0.0
Not applicable	98	34	34.7
$\chi 2$		7.7420	
P-value		0.1020	

Among the 514 Almajiris surveyed, the age group 16-20 years had the highest prevalence (40.5%), while the age group 6-10 years recorded the lowest prevalence (29.8%) (Table 4).

Table 4
Prevalence of urinary schistosomiasis among Age groups

Age (Years)	Number of samples Examined	Number of samples positive	Prevalence (%)
1 – 5	16	5	31.3
6 – 10	171	51	29.8
11 – 15	290	112	38.6
16 – 20	37	15	40.5
$\chi 2$			4.1680
P-value			0.2440

The participants who passed bloody urine had a higher prevalence than those who never passed blood in urine. While those with no history of praziquantel treatment had a higher prevalence than those who took praziquantel treatment (**Table 5**).

Table 5
Haematuria, History of Praziquantel Treatment, and Urinary Schistosomiasis among Almajiris in Dutsin-Ma, Kurfi, and Safana towns

Variables	Number Examined	Number positive	Prevalence (%)
Blood in Urine			
Yes	292	145	49.7
No	222	38	17.1
$\chi 2$		58.246	
P-value		0	
Praziquantel history			
Yes	82	33	40.2
No	432	150	34.7
$\chi 2$		0..9160	
P-value		0.338	
When last (Months)			
1	5	3	60
2	6	1	16.7
6	9	3	33.3
Can't remember	61	27	44.3
Not applicable	433	149	34.4
$\chi 2$		4.52	
P-value		0.34	

Discussion

In this study, we reported the current prevalence, spatial distribution, and the associated risk factors for urinary schistosomiasis. The current prevalence of urinary bilharziasis among Almajirai in this study was 35.6%. The prevalence rate in the study localities falls within the moderate-risk range (<50) based on the national prevalence range of Nigeria (Nduka et al., 2019). The occurrence of urinary schistosomiasis in this study corroborates previous findings from studies conducted in Katsina, Kaduna, and Sokoto in northwest Nigeria, as well as Maiduguri in the northeast region of Nigeria (Auta et al., 2020; Omenesa et al., 2015; Gamde et al., 2023; Balla et al., 2015).

In comparison, infection with *S. haematobium* was more prevalent in Dutsin-Ma town (46.5 %), than in Safana (31.4%) and Kurfi town (24.6%) (Table 1). Furthermore, the current prevalence of urinary schistosomiasis in Dutsin-Ma is higher than those reported in previous studies among primary and secondary school students in the area (Bawa et al., 2016; Atalabi et al, 2016). The increasing prevalence of *S. haematobium* infection in Dutsin-Ma Town may be attributable to the larger number of water bodies in the area compared to the other study localities (Figures 1 & 2).

On the other hand, Mallam Hamza TS recorded the highest prevalence of infection (60.7%), which classified the TS as a high-risk school among the TS studied, and the lowest prevalence (6.9%) was recorded in Mallam Audu TS (Table 2). The high prevalence recorded in this TS may be attributable to the source of water for the TS. The analyzed risk factors for the infection with *S. haematobium* in this survey include the type of water body; i.e. sourcing water from the river or dam, which was significantly associated with the infection ($\chi 2$=25.6160, P=0.0000) (Table 3).

In addition, age group was also significantly associated with the infection ($\chi 2$=50.6220, P=0.0000) (Table 4). This finding aligns with the previous reports in the study area, and could be attributable to the fact that the older Almajirai are more actively involved in recreational and domestic activities like; fishing, swimming, and washing their clothing in the rivers, streams, and dams than the younger age groups (Atalabi et al, 2016; Auta et al., 2020). Participants who passed bloody urine recorded a higher prevalence (49.7%) than those who never passed blood in their urine (17.1%), infection with *S. haematobium* was significantly associated with passing bloody urine ($\chi 2$= 58.2460, P= 0.0000). The presence of blood in the urine (haematuria) is a common symptom of urinary bilharziasis (Knopp et al, 2018). Similarly, those without a history of praziquantel treatment recorded a higher prevalence (40.2%) than those who took praziquantel treatment (34.7%) (Table 5). These findings are in tandem with previous studies that reported cultural practices and socio-economic variables among the risk factors for the transmission of urinary schistosomiasis in Nigeria (Amuta et al., 2014; Gamde et al., 2023).

CONCLUSION

This study found a prevalence of 35.6% of urinary schistosomiasis among the Almajiri population surveyed. Identified risk factors such as age, source

of water, frequency of contact with water bodies, and inaccessibility to the praziquantel regimen are contributory factors for the disease.

Implications

The study provides valuable information on the prevalence and risk factors for urinary schistosomiasis among Almajirai in Katsina State, Nigeria.

Applications

The findings of this study can be used to inform public health policies and practices aimed at controlling the spread of urinary schistosomiasis in Katsina state, Nigeria, and may serve as a baseline for future research on the disease and its transmission dynamics.

Recommendations

There is a need to upscale regular mass deworming programs for the Almajiri population in the studied areas, to reduce the prevalence of urinary schistosomiasis. Access to clean water should be provided, and the source of water should be regularly monitored for the snail intermediate hosts and treated appropriately with molluscicides. Public education campaigns on the risks and transmission of urinary schistosomiasis should be launched to raise awareness among the population and encourage improved environmental sanitation, and personal hygiene practices to prevent the further spread of the infection.

Limitations

The study only focused on Almajirai in a few Local Government Areas in Katsina State, Nigeria, which may be subject to recall bias. Further research should be conducted on the prevalence and risk factors for urinary schistosomiasis among the general populace in the region to provide more comprehensive data that can inform better interventions for the disease.

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Availability of Data and Materials

The dataset generated from this study is available from the corresponding author upon request.

Declarations

The State Ministry of Health Ethical Clearance Committee, Katsina State reviewed and approved the study protocol with approval Number; MOH/ADM/SUB/1152/1/555. Informed consent was obtained from the Mallams (guardians) of sampled children enlisted. Those unwilling to participate and did not consent were not recruited for the survey. Participants also had the liberty of withdrawing from the study at any time.

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Authors' Contribution

T.A. and S.R.H. designed the study. T.A., S.R.H., and E.D.A. carried out Laboratory Analyses, and T.A. Carried out the statistical analysis. S.R.H. and E.D.A. wrote the draft manuscript of the study. J.B.O. revised the draft manuscript. All authors revised and approved the final manuscript of the study.

Competing Interest

The authors had no competing interests.

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